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(54) **COOLING SYSTEM AND CONTROL METHOD THEREFOR**
KÜHLSYSTEM UND STEUERUNGSVERFAHREN DAFÜR
SYSTÈME DE REFROIDISSEMENT ET SON PROCÉDÉ DE COMMANDE

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Description

Related Applications

[0001] The present application claims the priority of Chinese Patent Application No. 201810845984.1, filed on July 27, 2018 and titled with "Cooling System and Control Method Thereof".

Technical Field

[0002] The present application relates to the field of cooling systems, in particular to a cooling system and a control method thereof.

Background Technology

[0003] A variable-frequency water cooling unit realizes adjustment of the operating load of the unit by changing the operating frequency (rotating speed) of a compressor unit so as to meet different cooling requirements. A frequency converter is a control system used to control and adjust the operating frequency (rotating speed) of the compressor unit. Therefore, guaranteeing the normal operation of the frequency converter is a prerequisite for stable operation of an air conditioning unit.

[0004] The frequency converter will generate heat under a working condition, and a rectifier module, an inverter module and a reactor are the main heat generation components. The greater the operating power of the frequency converter, the greater the heat generation; if the heat is not taken away in time, the temperature of the frequency converter will rise continuously; when the temperature is higher than a limit value, the components will be damaged and the frequency converter cannot work normally. In order to guarantee normal operation of the frequency converter, the cooling problem of the frequency converter needs to be solved.

[0005] A conventional frequency converter generally adopts a refrigerant for cooling; the cooling of the refrigerant has the advantages as follows: the cooling of the refrigerant directly adopts the liquid from the air conditioning unit; a cooling loop is a closed loop which is isolated from the environment to avoid the problem of scaling; the cooling efficiency of the refrigerant is high; the cooling system is simple in structure and small in size; the cooling of the refrigerant is also stable in temperature; and the cooling effect is good. However, in an existing refrigerant cooling system, the refrigerant will be throttled before cooling in the frequency converter; the temperature is relatively low; when the unit runs for a long time under a low-load working condition, as the operating power of the frequency converter is relatively small, the heat generation of the frequency converter is relatively low, and the refrigerant at a relatively low temperature enters the frequency converter to cause that the surface temperature of elements such as a refrigerant liquid supply copper pipe, a frequency converter cooling plate, etc. inside the frequency converter is too low; if the air tightness of the frequency converter is not good, wet air will enter the frequency converter to generate condensation water at these places of which the surface temperature is relatively low; and if the condensation water is accumulated in the frequency converter, damages of the frequency converter will be caused.

[0006] EP3264008A1 discloses a controller of a refrigeration apparatus that includes a temperature determination unit configured to determine whether a heat radiating unit temperature is within a target temperature range, a superheat degree calculation unit configured to calculate a degree of superheat of refrigerant flowing through an economizer from a state of refrigerant detected in a state detection unit, and an opening degree control unit configured, when the temperature determination unit determines that the heat radiating unit temperature is within the target temperature range, to control an opening degree of a flow rate regulation device so that the degree of superheat calculated in the superheat degree calculation unit reaches a target degree of superheat, and configured, when the temperature determination unit determines that the heat radiating unit temperature is outside the target temperature range, to control an opening degree of the flow rate regulation device so that the heat radiating unit temperature falls within the target temperature range.

[0007] CN203518310U discloses a cooling system for a heating power device. The cooling system comprises a first compressor, a first condenser, a main throttling device and an evaporator, all the parts are connected through refrigeration pipes to form a main refrigeration loop, a third port of the first condenser is connected with a throttling component and then connected with a third port of the evaporator, and the pipe between the throttling component and the third port of the evaporator is arranged nearby the heating power device. The cooling system further comprises an auxiliary refrigeration loop, the pipe between the third port of the first condenser and the throttling component is in parallel connection with the auxiliary refrigeration loop, and a second compressor and a second condenser are arranged on the auxiliary refrigeration loop.

Summary of the Invention

[0008] Based on this, the present application provides a cooling system and a control method thereof, which can solve the problems that condensation will be generated in the frequency converter when the compressor unit runs under a low-load working condition and the frequency converter will be damaged by burning due to overtemperature when the compressor unit runs under a high-load working condition.

[0009] In order to achieve the purpose of the present application, the present application adopts the following technical solutions:

A cooling system, comprising a compressor unit, a condenser, a first solenoid valve, a second solenoid valve, a first throttle valve and a frequency converter; the second solenoid valve and the first throttle valve are connected with the first solenoid valve in parallel after being connected in series; the compressor unit, the condenser, the first solenoid valve and the frequency converter are connected in series to form a first cooling loop; the compressor unit, the condenser, the second solenoid valve, the first throttle valve and the frequency converter are connected in series to form a second cooling loop; and the frequency converter is internally provided with a temperature detection module and a heat exchange module;

if the temperature detection module detects that the temperature in the frequency converter is lower than a switching temperature T, the first solenoid valve is opened, the second solenoid valve is closed, the first cooling loop is opened, and the second cooling loop is closed; and

if the temperature detection module detects that the temperature in the frequency converter is equal to or higher than the switching temperature T, the first solenoid valve is closed, the second solenoid valve is opened, the first cooling loop is closed, and the second cooling loop is opened.

[0010] According to the invention, the cooling system further comprises a cooling capacity adjustment module located between the compressor unit and the frequency converter, and the cooling capacity adjustment module is used to adjust the flow of the refrigerant passing through the frequency converter.

[0011] Further according to the invention, the cooling capacity adjustment module comprises at least one cooling capacity adjustment assembly, and each cooling capacity adjustment assembly comprises an electronic expansion valve.

[0012] In one of the embodiments, at least cooling capacity adjustment assemblies are provided, and the cooling capacity adjustment assemblies are arranged in parallel.

[0013] In one of the embodiments, each cooling capacity adjustment assembly further includes a third solenoid valve connected in parallel with the electronic expansion valve.

[0014] In one of the embodiments, the frequency converter is internally provided with an inverter module, a rectifier module and a reactor.

[0015] In one of the embodiments, the cooling system further comprises an evaporator located between the cooling capacity adjustment assembly and the compressor unit.

[0016] The invention also concerns control method of the cooling system, as specified in claim 6.

[0017] Optionally, the method can involve the further steps of claim 7.

[0018] In one of the embodiments, after the second cooling loop is opened, if the third solenoid valve is closed, and the operating opening degree of the electronic expansion valve is smaller than a set opening degree all the time within a set time, the cooling system is switched to the first cooling loop, and the second cooling loop is closed; during switching, the third solenoid valve is firstly opened, subsequently the first solenoid valve is opened, and then the second solenoid valve is closed to complete the switching.

[0019] In one of the embodiments, the set time is 30 min to 60 min.

[0020] In one of the embodiments, the set opening degree is smaller than or equal to 25% of the maximum opening degree.

[0021] The beneficial effects of the present application are that the cooling system of the present application adopts a first cooling loop without a first throttle valve and a second cooling loop with a first throttle valve; the first cooling loop can be used for cooling the frequency converter when the compressor unit runs under a low-load working condition; the refrigerant in the first cooling loop is not throttled before entering the frequency converter, and the temperature of liquid supply is relatively high, so the first cooling loop can realize the cooling of the frequency converter when the compressor unit runs under a low-load working condition so as to prevent condensation of the frequency converter; the second cooling loop can be used for cooling the frequency converter when the compressor unit runs under a high-load working condition, the refrigerant in the second cooling loop is throttled by the first throttle valve before entering the frequency converter, and the temperature of the throttled refrigerant is relatively low, so the frequency converter can be provided with sufficient cooling capacity, and thus over-temperature of the frequency converter hardly occur.

Brief Description of Drawings

[0022] In order to more clearly describe the technical solutions in the embodiments of the present application or in the prior art, the drawings that need to be used in the description of the embodiments or the prior art will be briefly introduced below; obviously, the drawings in the following description are only the embodiments of the present application; and for those of ordinary skilled in the art, other drawings can further be obtained from the disclosed drawings without creative work.

[0023] Fig.1 is a working principle diagram of one embodiment of the present application.

[0024] In Fig.1:

10. Compressor unit; 20. Condenser; 30. First solenoid valve; 41. Second solenoid valve; 42. First throttle valve; 50. Frequency converter; 51. Reactor; 52. Inverter module; 53. Rectifier module; 60. Evaporator; 70. Cooling capacity adjustment module; 71. Cooling capacity adjustment assembly; 72. Electronic expansion valve; 73. Third solenoid valve; 80. Flash generator; 91. Second throttle valve; 92. Third throttle valve.

Detailed Description of the Embodiments

[0025] The technical solutions in the embodiments of the present application will be described clearly and completely below in combination with the drawings in the embodiments of the present application; and apparently, the described embodiments are only a part of the embodiments of the present application instead of all of the embodiments. Based on the embodiments in the present application, all other embodiments obtained by those of ordinary skill in the art without making any creative work fall within the protection scope of the present application, as defined by the appended claims.

[0026] In the description of the present application, it should be understood that the orientation or positional relationship indicated by the terms "length", "width", "top", "bottom", "inside", "outside", etc. is based on the orientation or positional relationship shown in the drawings, and is only for conveniently describing the present application and simplifying the description, rather than indicating or implying that the referred device or element must have a specific orientation and be constructed and operated in a specific orientation, and therefore it cannot be understood as a limitation of the present application.

[0027] In addition, the terms "first" and "second" are only used for a descriptive purpose, and cannot be understood as indicating or implying relative importance or implicitly indicating the number of indicated technical features. Thus, the features defined with "first" and "second" may explicitly or implicitly include one or more of these features.

[0028] In the description of the present application, unless otherwise clearly stated and limited, the terms "connected" and "fixed" should be understood in a broad sense; for example, it may be a fixed connection, or a detachable connection, or an integrated connection; it may be a mechanical connection or an electric connection; it may be a direct connection or an indirect connection through an intermediate medium; and it may be an internal communication between two elements or an interaction relationship between two elements. For those of ordinary skill in the art, the specific meanings of the above-mentioned terms in the present application can be understood under specific circumstances.

[0029] In the present application, unless otherwise clearly stated and defined, the first feature is "on" or "under" the second feature may include that the first feature and the second feature have direct contact, or may include that the first feature and the second feature have no direct contact but have a contact through other features therebetween.

[0030] The technical solutions of the present application will be further described below through specific embodiments in combination with the drawings.

[0031] As shown in Fig.1, a cooling system of one embodiment of the present application is provided; the cooling system comprises a compressor unit 10, a condenser 20, a first solenoid valve 30, a second solenoid valve 41, a first throttle valve 42 and a frequency converter 50; the second solenoid valve 41 and the first throttle valve 42 are connected in series and connected with the first solenoid valve 30 in parallel; the compressor unit 10, the condenser 20, the first solenoid valve 30 and the frequency converter 50 are connected in series to form a first cooling loop; the compressor unit 10, the condenser 20, the second solenoid valve 41, the first throttle valve 42 and the frequency converter 50 are connected in series to form a second cooling loop; the frequency converter 50 is internally provided with a temperature detection module and a heat exchange module; and the heat exchange module is used for exchanging heat with the refrigerant to cool the frequency converter 50.

[0032] If the temperature detection module detects that the temperature in the frequency converter 50 is lower than the switching temperature, the first solenoid valve 30 is opened, the second solenoid valve 41 is closed, and the first cooling loop is opened; as the refrigerant in the first cooling loop is not throttled before entering the frequency converter 50, the temperature is relatively high, and thus the frequency converter 50 can be prevented from condensation when the compressor unit runs under a low-load working condition; if the temperature detection module detects that the temperature of the frequency converter 50 is higher than or equal to the switching temperature T, the first solenoid valve 30 is closed, the second solenoid valve 41 is opened, the first cooling loop is closed, and the cooling system is switched to the second cooling loop; as the refrigerant in the second cooling loop is firstly throttled by the first throttle valve 42 before entering the frequency converter 50, the temperature of the throttled refrigerant is relatively low, the frequency converter can be provided with sufficient cooling capacity, so that the frequency converter 50 hardly generate overtemperature when the compressor unit 10 runs under a high-load working condition.

[0033] Besides the temperature detection module and the heat exchange module, the frequency converter 50 is further internally provided with an inverter module 52, a rectifier module 53 and a reactor 51.

[0034] Optionally, the cooling system further comprises a cooling capacity adjustment module 70 located between the compressor unit 10 and the frequency converter 50, and the cooling capacity adjustment module 70 is used to adjust the flow of the refrigerant passing through the frequency converter 50 so as to adjust the cooling capacity of the frequency converter. The cooling capacity adjustment module 70 comprises at least one cooling capacity adjustment assembly 71, and each cooling capacity adjustment assembly 71 comprises an electronic expansion valve 72.

[0035] When the temperature of the frequency converter 50 is within the target temperature range T0, the opening degree of the electronic expansion valve 72 is maintained at the current opening degree; when the temperature of the frequency converter 50 is higher than Tb, the opening degree of the electronic expansion valve 72 becomes larger to increase the cooling capacity of the refrigerant to the frequency converter, thereby accelerating the cooling of the frequency converter 50; when the temperature of the frequency converter 50 is lower than the target temperature range T0, the opening degree of the electronic expansion valve 72 becomes smaller to reduce the cooling capacity of the refrigerant to the frequency converter 50, so that the frequency converter 50 can be heated to a target temperature range, thereby preventing condensation caused by excessive low temperature of the frequency converter 50.

[0036] Once the temperature detection module detects that the temperature of the frequency converter 50 is over-temperature, the compressor unit 10 will be shut down, but the frequency converter 50 will not generate condensation by a low temperature within a short time, so the electronic expansion valve 72 is opened quickly and closed slowly, namely the electronic expansion valve 72 is opened as quickly as possible to prevent over temperature of the frequency converter 50; for example, when the electronic expansion valve 72 is to be opened, every 5 seconds are considered as one action period; the electronic expansion valve 72 is opened by 20 steps (the total opening degree is 480 steps) in each action; the electronic expansion valve 72 can be closed a little slowly to prevent large temperature fluctuation; for example, when the electronic expansion valve 72 is to be closed, every five minutes are considered as one action period; and the electronic expansion valve 72 is closed by 10% based on the current opening degree in each action.

[0037] In order to reduce the workload of each electronic expansion valve 72, in one embodiment, at least cooling capacity adjustment assemblies 71 are provided, and the cooling capacity adjustment assemblies 71 are arranged in parallel.

[0038] Further, each cooling capacity adjustment assembly 71 further comprises a third solenoid valve 73 connected in parallel with the electronic expansion valve 72; the third solenoid valve 73 is controlled to be opened and closed according to a set temperature T1 of a first frequency converter and a set temperature T2 of a second frequency converter, wherein $T2<Ta<Tb<T1<T$; when the temperature of the frequency converter 50 is higher than the set temperature T1 of the first frequency converter, the third solenoid valve 73 is opened to increase the cooling capacity for the frequency converter 50, so that the frequency converter 50 is cooled, and thus the frequency converter 50 can be prevented from being burned out due to high temperature. When the third solenoid valve 73 is opened, the electronic expansion valve 72 connected in parallel with the third solenoid valve 73 is continuously opened until it is completely opened; when the temperature of the frequency converter 50 is lower than the set temperature T2, the third solenoid valve 73 is closed to reduce the cooling capacity of the frequency converter 50, so that the frequency converter 50 is heated to prevent condensation; and after the third solenoid valve 73 is closed, the opening degree of the electronic expansion valve 72 is controlled according to whether the temperature of the frequency converter 50 exceeds the target temperature range T0 or not.

[0039] When the second solenoid valve 41 and the third solenoid valve 73 are both opened, if the temperature detection module detects that the temperature of the frequency converter 50 is still higher than the switching temperature T all the time, maybe the condenser 20 has a fault which causes failed cooling of the frequency converter 50; in other implementable embodiments, the frequency converter 50 can be internally provided with a backup cooling module; when the temperature of the frequency converter 50 does not fall below a second target temperature range within a specified time, an external control device can be used to control the backup cooling module to work to cool the frequency converter 50 so as to reduce the temperature of the frequency converter 50 and prevent the working parts inside the frequency converter 50 from being burned out due to high temperature; for example, the backup cooling module adopts a semiconductor refrigerating device or other devices that can realize cooling of the frequency converter 50.

[0040] The cooling system further comprises an evaporator 60 located between the cooling capacity adjustment assembly 71 and the compressor unit 10, and the evaporator 60 is used to cool the cooling liquid passing through the frequency converter 50 again, so that the refrigerant can realize better cooling of the compressor unit 10 in work.

[0041] The cooling system further comprises a flash generator 80, and the condenser 20, the flash generator 80, the evaporator 60 and the compressor unit 10 are connected in series to form a refrigeration loop for cooling a room.

[0042] A pipeline connecting the flash generator 80 with the evaporator 60 is provided with a second throttle valve 91, a pipeline connecting the condenser 20 with the flash generator 80 is provided with a third throttle valve 92, and the second throttle valve 91 and the third throttle valve 92 are both used to adjust the flow of the refrigeration loop as required.

[0043] The above-mentioned cooling system adopts a first cooling loop without a first throttle valve 42 and a second cooling loop with a first throttle valve 42; the first cooling loop can be used for cooling the frequency converter when the compressor unit 10 runs under a low-load working condition; the refrigerant in the first cooling loop is not throttled before entering the frequency converter 50, and the temperature of liquid supply is relatively high, so the refrigerant can realize the cooling of the frequency converter 50 when the compressor unit 10 runs under a low-load working condition so as to prevent condensation of the frequency converter 50; the second cooling loop can be used when the compressor unit runs under a high-load working condition; the refrigerant in the second cooling loop is throttled by the first throttle valve 42 before entering the frequency converter 50, and the temperature of the throttled refrigerant is relatively low, so the refrigerant can realize the cooling of the frequency converter 50 when the compressor unit 10 runs under a high-load working condition. On the above basis, the third solenoid valve 73 is added to assist liquid supply of the electronic expansion valve 72; when the temperature of the frequency converter 50 is too high, the third solenoid valve 73 is opened quickly to increase the cooling flow passing through the frequency converter 50 and prevent over temperature of the frequency converter 50. During the operation of the compressor unit 10, by the control conception and method of quick opening and slow closing of the electronic expansion valve 72 and according to the load working condition of the compressor unit 10, the first cooling loop and the second cooling loop are flexibly switched by mutual cooperation of all valves, thereby effectively improving the reliability of the frequency converter and the compressor unit 10.

[0044] The present application further discloses a control method of the cooling system, and based on the above-mentioned cooling system, the control method specifically includes the following steps of:

S1, detecting the temperature in the frequency converter 50 by using the temperature detection module.

S2, if the temperature detection module detects that the temperature in the frequency converter 50 is lower than the switching temperature T, opening the first solenoid valve 30, closing the second solenoid valve 41, opening the first cooling loop, and closing the second cooling loop.

S3, if the temperature detection module detects that the temperature in the frequency converter 50 is equal to or higher than the switching temperature T, closing the first cooling loop, and opening the second cooling loop.

[0045] In one of the embodiments, the opening degree of the electronic expansion valve 72 is controlled by comparing whether the temperature of the frequency converter 50 exceeds the target temperature range T0 (Ta, Tb) or not, wherein Ta <Tb<T; if the temperature detection module detects that the temperature of the frequency converter 50 is within the target temperature range T0, the opening degree of the electronic expansion valve 72 is maintained at the current opening degree without any change; if the temperature detection module detects that the temperature of the frequency converter 50 is higher than Tb, the opening degree of the electronic expansion valve 72 is increased; and if the temperature detection module detects that the temperature of the frequency converter 50 is lower than Ta, the opening degree of the electronic expansion valve 72 is reduced.

[0046] In one of the embodiments, the opening and closing of the third solenoid valve 73 is controlled according to a set temperature T1 of a first frequency converter and a set temperature T2 of a second frequency converter, wherein T2<T0<T1<T; if the temperature detection module detects that the temperature of the frequency converter 50 is higher than the set temperature T1 of the first frequency converter, the third solenoid valve 73 is opened, the opening degree of the electronic expansion valve 72 is continuously increased until reaching the maximum opening degree; if the temperature detection module detects that the temperature of the frequency converter 50 is lower than the set temperature T2 of the second frequency converter, the third solenoid valve 73 is closed, and afterwards the operation of the opening degree of the electronic expansion valve 72 is controlled by comparing whether the temperature of the frequency converter 50 exceeds the target temperature range T0 or not.

[0047] In one of the embodiments, after the second cooling loop is opened, if the third solenoid valve 73 is closed, and the operating opening degree of the electronic expansion valve 72 is smaller than a set opening degree all the time within a set time, the cooling system is switched to the first cooling loop, and the second cooling loop is closed; during switching, as the compressor unit 10 is under a high-load working condition, in order to maintain normal temperature of the frequency converter, the third solenoid valve 73 is firstly opened, subsequently the first solenoid valve 30 is opened, and then the second solenoid valve 41 is closed to complete the switching.

[0048] In one embodiment, the predetermined time is 1 min to 60 min, for example, the predetermined time may be 10 min, 15 min, 20 min, 25 min, 30 min, 35 min, 40 min, 45 min, 50 min or 55 min.

[0049] In one embodiment, the set opening degree is smaller than or equal to 25% of the maximum opening degree. In this embodiment, the set opening degree is chosen to be 25% of the maximum opening degree.

[0050] The technical features of the above-mentioned embodiments can be combined randomly; in order to make the description concise, not all possible combinations of the various technical features in the above-mentioned embodiments are described, however, as long as there is no contradiction in the combinations of these technical features, all should be considered as the scope of this specification.

[0051] The above-mentioned embodiments only express several implementation modes of the present application, and the description thereof is relatively specific and detailed, but it should not be understood as a limitation to the patent scope of the present application. It should be noted that, for those of ordinary skill in the art, without departing from the concept of the present application, a plurality of modifications and improvements can be made as well, which all fall within the protection scope of the present application. The protection scope is defined by the appended claims.

Claims

1. A cooling system, comprising a compressor unit (10), a condenser (20), a first solenoid valve (30), a second solenoid valve (41), a first throttle valve (42) and a frequency converter (50), wherein the second solenoid valve (41) and the first throttle valve (42) are connected in series and connected with the first solenoid valve (30) in parallel; the compressor unit (10), the condenser (20), the first solenoid valve (30) and the frequency converter (50) are connected in series to form a first cooling loop; the compressor unit (10), the condenser (20), the second solenoid valve (41), the first throttle valve (42) and the frequency converter (50) are connected in series to form a second cooling loop; and the frequency converter (50) is internally provided with a temperature detection module and a heat exchange module;

   the cooling system further comprising a cooling capacity adjustment module (70) located between the compressor unit (10) and the frequency converter (50) to adjust the flow of the refrigerant passing through the frequency converter (50); and
   the cooling capacity adjustment module (70) comprises at least one cooling capacity adjustment assembly (71), and each cooling capacity adjustment assembly (71) comprises an electronic expansion valve (72);
   wherein the cooling system is configured such that if the temperature detection module detects that the temperature in the frequency converter (50) is lower than a switching temperature T, the first solenoid valve (30) is opened, the second solenoid valve (41) is closed, the first cooling loop is opened, and the second cooling loop is closed; and
   wherein the cooling system is configured such that if the temperature detection module detects that the temperature in the frequency converter (50) is equal to or higher than the switching temperature T, the first solenoid valve (30) is closed, the second solenoid valve (41) is opened, the first cooling loop is closed, and the second cooling loop is opened.

2. The cooling system according to claim 1, wherein at least cooling capacity adjustment assemblies (71) are provided, and the cooling capacity adjustment assemblies (71) are arranged in parallel.

3. The cooling system according to claim 2, wherein each cooling capacity adjustment assembly (71) further comprises a third solenoid valve (73) connected in parallel with the electronic expansion valve (72).

4. The cooling system according to claim 1, wherein the frequency converter (50) is internally provided with an inverter module (52), a rectifier module (53) and a reactor (51).

5. The cooling system according to claim 1, further comprising an evaporator (60) located between the cooling capacity adjustment assembly (71) and the compressor unit (10).

6. A control method of the cooling system according to claim 1, comprising the following steps of:

   detecting the temperature in the frequency converter (50) by using the temperature detection module;
   if the temperature in the frequency converter (50) is lower than the switching temperature T, opening the first solenoid valve (30), closing the second solenoid valve (41), opening the first cooling loop, and closing the second cooling loop;
   if the temperature in the frequency converter (50) is equal to or higher than the switching temperature T, closing the first solenoid valve (30), opening the second solenoid valve (41), closing the first cooling loop, and opening the second cooling loop; and
   controlling the opening degree of the electronic expansion valve (72) according to whether the temperature of the frequency converter (50) exceeds the target temperature range T0 (Ta, Tb) or not, wherein Tb<T; if the temperature detection module detects that the temperature of the frequency converter (50) is within the target temperature range T0, maintaining the opening degree of the electronic expansion valve (72) at a predetermined size; if the temperature detection module detects that the temperature of the frequency converter (50) is higher than Tb, increasing the opening degree of the electronic expansion valve (72); if the temperature detection module detects that the temperature of the frequency converter (50) is lower than the target temperature range Ta, reducing the opening degree of the electronic expansion valve (72).

7. A control method of the cooling system according to claim 6, each cooling capacity adjustment assembly (71) further comprises a third solenoid valve (73) connected in parallel with the electronic expansion valve (72), the control method comprises the following steps of:
   the opening and closing of the third solenoid valve (73) is controlled according to a set temperature T1 of a first frequency converter and a set temperature T2 of a second frequency converter, wherein T2<Ta<Tb<T1<T; if the temperature detection module detects that the temperature of the frequency

converter (50) is higher than the set temperature T1 of the first frequency converter, the third solenoid valve (73) is opened, the opening degree of the electronic expansion valve (72) is continuously increased until reaching the maximum opening degree; if the temperature detection module detects that the temperature of the frequency converter (50) is lower than the set temperature T2 of the second frequency converter, the third solenoid valve (73), and afterwards the operation of the opening degree of the electronic expansion valve (72) is controlled by comparing whether the temperature of the frequency converter (50) exceeds the target temperature range T0 or not.

8. The control method of the cooling system according to claim 7, wherein after the second cooling loop is opened, if the third solenoid valve (73) is closed, and the operating opening degree of the electronic expansion valve (72) is smaller than a set opening degree all the time within a set time, the cooling system is switched to the first cooling loop, and the second cooling loop is closed; during switching, the third solenoid valve (73) is firstly opened, subsequently the first solenoid valve (30) is opened, and then the second solenoid valve (41) is closed to complete the switching.

9. The control method of the cooling system according to claim 8, wherein the predetermined time is 1 min to 60 min.

10. The control method of the cooling system according to claim 8, wherein the set opening degree is smaller than or equal to 25% of the maximum opening degree.

Patentansprüche

1. Kühlsystem, das eine Kompressoreinheit (10), einen Kondensator (20), ein erstes Magnetventil (30), ein zweites Magnetventil (41), ein erstes Drosselventil (42) und einen Frequenzumrichter (50) umfasst, wobei das zweite Magnetventil (41) und das erste Drosselventil (42) in Reihe geschaltet und mit dem ersten Magnetventil (30) parallel geschaltet sind; die Kompressoreinheit (10), der Kondensator (20), das erste Magnetventil (30) und der Frequenzumrichter (50) in Reihe geschaltet sind, um einen ersten Kühlkreislauf zu bilden; die Kompressoreinheit (10), der Kondensator (20), das zweite Magnetventil (41), das erste Drosselventil (42) und der Frequenzumrichter (50) in Reihe geschaltet sind, um einen zweiten Kühlkreislauf zu bilden; und der Frequenzumrichter (50) intern mit einem Temperaturerfassungsmodul und einem Wärmeaustauschmodul versehen ist;

wobei das Kühlsystem ferner ein Kühlleistungseinstellmodul (70) zwischen der Kompressoreinheit (10) und dem Frequenzumrichter (50) umfasst, um den Strom des durch den Frequenzumrichter (50) strömenden Kühlmittels einzustellen; und

das Kühlleistungseinstellmodul (70) mindestens eine Kühlleistungseinstellbaugruppe (71) umfasst und jede Kühlleistungseinstellbaugruppe (71) ein elektronisches Expansionsventil (72) umfasst;

wobei das Kühlsystem so konfiguriert ist, dass, wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur im Frequenzumrichter (50) niedriger als eine Umschalttemperatur T ist, das erste Magnetventil (30) geöffnet wird, das zweite Magnetventil (41) geschlossen wird, der erste Kühlkreislauf geöffnet wird und der zweite Kühlkreislauf geschlossen wird; und

wobei das Kühlsystem so konfiguriert ist, dass, wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur im Frequenzumrichter (50) gleich der oder höher als die Schalttemperatur T ist, das erste Magnetventil (30) geschlossen wird, das zweite Magnetventil (41) geöffnet wird, der erste Kühlkreislauf geschlossen und der zweite Kühlkreislauf geöffnet wird.

2. Kühlsystem nach Anspruch 1, wobei mindestens Kühlleistungseinstellbaugruppen (71) vorgesehen sind und die Kühlleistungseinstellbaugruppen (71) parallel angeordnet sind.

3. Kühlsystem nach Anspruch 2, wobei jede Kühlleistungseinstellbaugruppe (71) ferner ein drittes Magnetventil (73) umfasst, das parallel zu dem elektronischen Expansionsventil (72) geschaltet ist.

4. Kühlsystem nach Anspruch 1, wobei der Frequenzumrichter (50) intern mit einem Wechselrichtermodul (52), einem Gleichrichtermodul (53) und einem Reaktor (51) versehen ist.

5. Kühlsystem nach Anspruch 1, das ferner einen Verdampfer (60) zwischen der Kühlleistungseinstellbaugruppe (71) und der Kompressoreinheit (10) umfasst.

6. Verfahren zum Steuern des Kühlsystems nach Anspruch 1, das die folgenden Schritte beinhaltet:

Erfassen der Temperatur im Frequenzumrichter (50) mittels des Temperaturerfassungsmoduls; wenn die Temperatur im Frequenzumrichter (50) niedriger ist als die Umschalttemperatur T, Öffnen des ersten Magnetventils (30), Schließen des zweiten Magnetventils (41), Öffnen des ersten Kühlkreislaufs und Schließen des zweiten Kühlkreislaufs;

wenn die Temperatur im Frequenzumrichter (50) gleich der oder höher als die Umschalttemperatur T ist, Schließen des ersten Magnetventils (30), Öffnen des zweiten Magnetventils (41), Schließen des ersten Kühlkreislaufs und Öffnen des zweiten Kühlkreislaufs; und

Steuern des Öffnungsgrads des elektronischen Expansionsventils (72) je nachdem, ob die Temperatur des Frequenzumrichters (50) den Zieltemperaturbereich T0 (Ta, Tb) überschreitet oder nicht, wobei Tb<T; Halten, wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur des Frequenzumrichters (50) innerhalb des Zieltemperaturbereichs T0 liegt, des Öffnungsgrads des elektronischen Expansionsventils (72) auf einer vorbestimmten Größe; Erhöhen, wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur des Frequenzumrichters (50) höher als Tb ist, des Öffnungsgrads des elektronischen Expansionsventils (72); Verringern, wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur des Frequenzumrichters (50) niedriger als der Zieltemperaturbereich Ta ist, des Öffnungsgrads des elektronischen Expansionsventils (72).

7. Verfahren zum Steuern des Kühlsystems nach Anspruch 6, wobei jede Kühlleistungseinstellbaugruppe (71) ferner ein drittes Magnetventil (73) umfasst, das parallel zu dem elektronischen Expansionsventil (72) geschaltet ist, wobei das Steuerverfahren die folgenden Schritte beinhaltet:

Steuern des Öffnens und Schließens des dritten Magnetventils (73) gemäß einer eingestellten Temperatur T1 eines ersten Frequenzumrichters und einer eingestellten Temperatur T2 eines zweiten Frequenzumrichters, wobei T2<Ta<Tb<Tl<T; wenn das Temperaturerfassungsmodul erfasst, dass die Temperatur des Frequenzumrichters (50) höher ist als die eingstellte Temperatur T1 des ersten Frequenzumrichters, Öffnen des dritten Magnetventils (73), kontinuierliches Erhöhen des Öffnungsgrads des elektronischen Expansionsventils (72), bis der maximale Öffnungsgrad erreicht ist; wenn das Temperaturerkennungsmodul erfasst, dass die Temperatur des Frequenzumrichters (50) niedriger ist als die eingestellte Temperatur T2 des zweiten Frequenzumrichters, [sic] des dritten Magnetventils (73), und anschließend Steuern des Betriebs des Öffnungsgrads des elektronischen Expansionsventils (72) durch Vergleichen, ob die Temperatur des Frequenzumrichters (50) den Zieltemperaturbereich T0 überschreitet oder nicht.

8. Verfahren zum Steuern des Kühlsystems nach Anspruch 7, wobei nach dem Öffnen des zweiten Kühlkreislaufs, wenn das dritte Magnetventil (73) geschlossen ist und der Betriebsöffnungsgrad des elektronischen Expansionsventils (72) die ganze Zeit innerhalb einer eingestellten Zeit kleiner als ein eingestellter Öffnungsgrad ist, das Kühlsystem auf den ersten Kühlkreislauf umgeschaltet und der zweite Kühlkreislauf geschlossen wird; während des Umschaltens zuerst das dritte Magnetventil (73) geöffnet wird, anschließend das erste Magnetventil (30) geöffnet und dann das zweite Magnetventil (41) geschlossen wird, um das Umschalten abzuschließen.

9. Verfahren zum Steuern des Kühlsystems nach Anspruch 8, wobei die vorbestimmte Zeit 1 min bis 60 min beträgt.

10. Verfahren zum Steuern des Kühlsystems nach Anspruch 8, wobei der eingestellte Öffnungsgrad gleich oder kleiner als 25 % des maximalen Öffnungsgrads ist.

Revendications

1. Système de refroidissement, comprenant une unité de compresseur (10), un condenseur (20), une première électrovanne (30), une deuxième électrovanne (41), une première soupape d’étranglement (42) et un convertisseur de fréquence (50), dans lequel la deuxième électrovanne (41) et la première soupape d’étranglement (42) sont connectées en série et connectées à la première électrovanne (30) en parallèle ; l’unité de compresseur (10), le condenseur (20), la première électrovanne (30) et le convertisseur de fréquence (50) sont connectés en série pour former une première boucle de refroidissement ; l’unité de compresseur (10), le condenseur (20), la deuxième électrovanne (41), la première soupape d’étranglement (42) et le convertisseur de fréquence (50) sont connectés en série pour former une seconde boucle de refroidissement; et le convertisseur de fréquence (50) est doté en son intérieur d’un module de détection de température et d’un module d’échange de chaleur ;

le système de refroidissement comprenant en outre un module de réglage de capacité de refroidissement (70) situé entre l’unité de compresseur (10) et le convertisseur de fréquence (50) pour régler le débit du réfrigérant passant par le convertisseur de fréquence (50) ; et

le module de réglage de capacité de refroidissement (70) comprend au moins un ensemble de réglage de capacité de refroidissement (71) et chaque ensemble de réglage de capacité de refroidissement (71) comprend un détendeur électronique (72) ;

dans lequel le système de refroidissement est configuré de telle sorte que si le module de détection de température détecte que la température dans le convertisseur de fréquence (50) est inférieure à une température de commutation T, la première électrovanne (30) soit ouverte, la deuxième électrovanne (41) soit fermée, la première boucle de refroidissement soit ouverte et la seconde boucle de refroidissement soit fermée ; et

dans lequel le système de refroidissement est configuré de telle sorte que si le module de détection de température détecte que la température dans le convertisseur de fréquence (50) est égale ou supérieure à la température de commutation T, la première électrovanne (30) soit fermée, la deuxième électrovanne (41) soit ouverte, la première boucle de refroidissement soit fermée et la seconde boucle de refroidissement soit ouverte.

2. Système de refroidissement selon la revendication 1, dans lequel au moins des ensembles de réglage de capacité de refroidissement (71) sont fournis et les ensembles de réglage de capacité de refroidissement (71) sont disposés en parallèle.

3. Système de refroidissement selon la revendication 2, dans lequel chaque ensemble de réglage de capacité de refroidissement (71) comprend en outre une troisième électrovanne (73) connectée en parallèle au détendeur électronique (72).

4. Système de refroidissement selon la revendication 1, dans lequel le convertisseur de fréquence (50) est doté en son intérieur d'un module onduleur (52), d'un module redresseur (53) et d'un réacteur (51).

5. Système de refroidissement selon la revendication 1, comprenant en outre un évaporateur (60) situé entre l'ensemble de réglage de capacité de refroidissement (71) et l'unité de compresseur (10).

6. Procédé de commande du système de refroidissement selon la revendication 1, comprenant les étapes suivantes :

la détection de la température dans le convertisseur de fréquence (50) à l'aide du module de détection de température ;

si la température dans le convertisseur de fréquence (50) est inférieure à la température de commutation T, l'ouverture de la première électrovanne (30), la fermeture de la deuxième électrovanne (41), l'ouverture de la première boucle de refroidissement et la fermeture de la seconde boucle de refroidissement ;

si la température dans le convertisseur de fréquence (50) est égale ou supérieure à la température de commutation T, la fermeture de la première électrovanne (30), l'ouverture de la deuxième électrovanne (41), la fermeture de la première boucle de refroidissement et l'ouverture de la seconde boucle de refroidissement; et

la commande du degré d'ouverture du détendeur électronique (72) selon que la température du convertisseur de fréquence (50) dépasse ou non la plage de température cible T0 (Ta, Tb), dans lequel Tb<T ; si le module de détection de température détecte que la température du convertisseur de fréquence (50) est comprise dans la plage de température cible T0, le maintien du degré d'ouverture du détendeur électronique (72) à une taille prédéterminée ; si le module de détection de température détecte que la température du convertisseur de fréquence (50) est supérieure à Tb, l'augmentation du degré d'ouverture du détendeur électronique (72) ; si le module de détection de température détecte que la température du convertisseur de fréquence (50) est inférieure à la plage de température cible Ta, la réduction du degré d'ouverture du détendeur électronique (72).

7. Procédé de commande du système de refroidissement selon la revendication 6, chaque ensemble de réglage de capacité de refroidissement (71) comprenant en outre une troisième électrovanne (73) connectée en parallèle au détendeur électronique (72), le procédé de commande comprenant les étapes suivantes :

la commande de l'ouverture et de la fermeture de la troisième électrovanne (73) en fonction d'une température de consigne T1 d'un premier convertisseur de fréquence et d'une température de consigne T2 d'un second convertisseur de fréquence, dans lequel T2 < Ta < Tb < T1 < T ; si le module de détection de température détecte que la température du convertisseur de fréquence (50) est supérieure à la température de consigne T1 du premier convertisseur de fréquence, la troisième électrovanne (73) est ouverte, le degré d'ouverture du détendeur électronique (72) est continuellement augmenté jusqu'à atteindre le degré d'ouverture maximal ; si le module de détection de température détecte que la température du convertisseur de fréquence (50) est inférieure à la température de consigne T2 du second convertisseur de fréquence, la troisième électrovanne (73), puis le fonctionnement du degré d'ouverture du détendeur électronique (72), sont commandés selon que la température du convertisseur de fréquence (50) dépasse ou non la plage de température cible T0.

8. Procédé de commande du système de refroidissement selon la revendication 7, dans lequel après l'ouverture de la seconde boucle de refroidissement, si la troisième électrovanne (73) est fermée, et le degré d'ouverture de fonctionnement du détendeur électronique (72) est inférieur à un degré d'ouverture défini tout le temps dans un temps défini, le système de refroidissement est commuté sur la première boucle de refroidissement, et la seconde boucle de refroidissement est fermée ; durant la commutation, la troisième électrovanne (73) est d'abord ouverte, puis la première électrovanne (30) est ouverte, puis la deuxième électrovanne (41) est fermée pour terminer la commutation.

9. Procédé de commande du système de refroidissement selon la revendication 8, dans lequel le temps prédéterminé est de 1 min à 60 min.

10. Procédé de commande du système de refroidissement selon la revendication 8, dans lequel le degré d'ouverture défini est inférieur ou égal à 25 % du degré d'ouverture maximal.

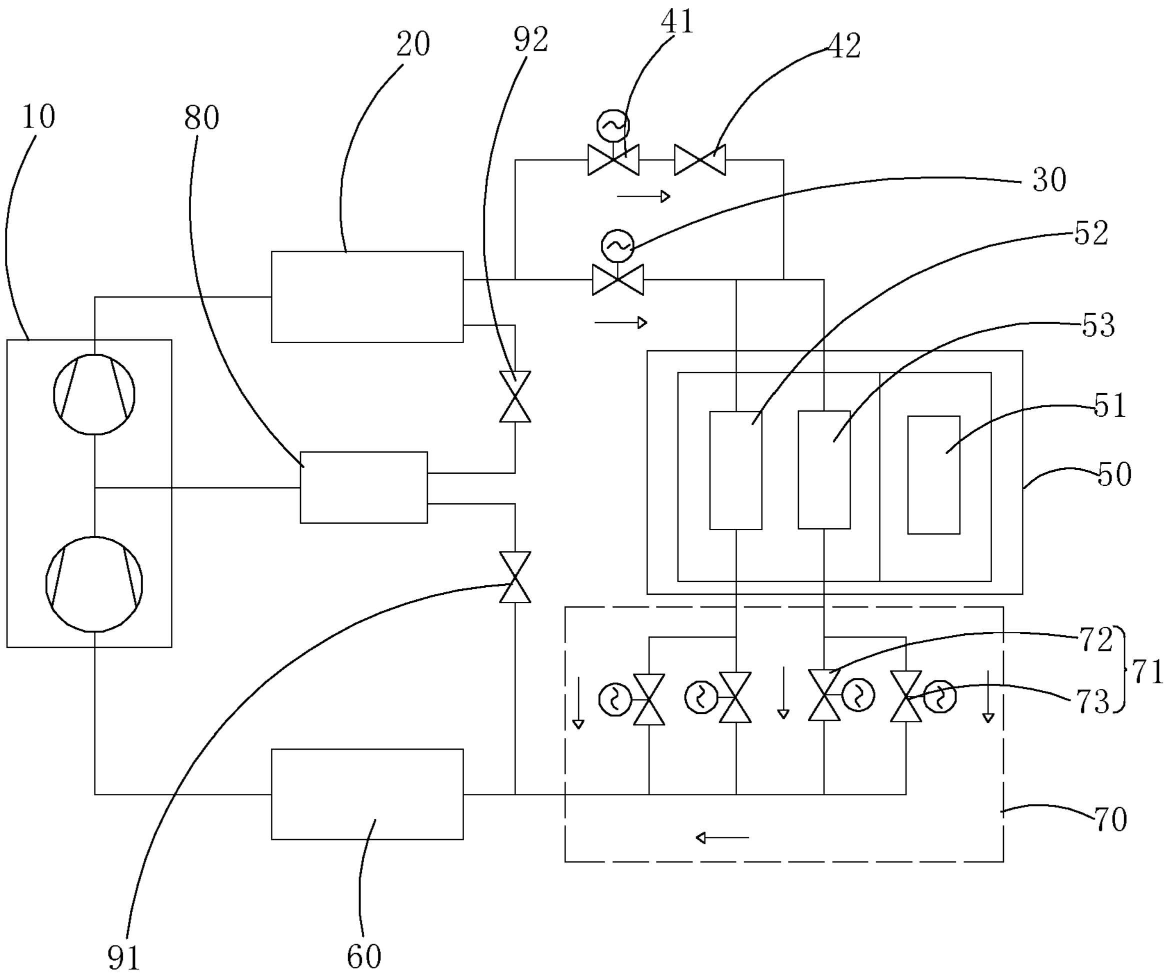

Fig.1

REFERENCES CITED IN THE DESCRIPTION

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